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The Authors only are responsible for the statements and opinions expressed in their respective Papers.

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LIVERPOOL GEOLOGICAL ASSOCIATION,

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Established 3rd June, 1880.

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LIVERPOOL GEOLOGICAL ASSOCIATION,

FREE LIBRARY, WILLIAM BROWN STREET.

Established 3rd June, 1880.

A SPECIAL MEETING

Was held in the Free Library on Monday, November 4th, 1895, the President (Mr. T. R. Connell) in the Chair.

It was unanimously resolved that Rule 4 be altered by the insertion of the word *two* before Vice-President, so that it shall read "The Officers of the Association shall be a President, *two* Vice-Presidents, &c."

ORDINARY MEETING

Held Monday, November 4th, 1895, the President (Mr. T. R. Connell) in the Chair.

ELECTION.—In consequence of the resolution of the Special Meeting, a second Vice-President was required, and Mr. G. A. Haworth was unanimously elected to that office.

COMMUNICATION.—The President announced that the new Council had met to arrange the work of the year, and had appointed the Officers and Committees, other than the Executive Council as stated on page 1 of the Journal.

EXHIBIT.—Mr. C. Potter exhibited a jug covered with dendritic markings artificially produced, and presented it to the Association.

The President then gave his ANNUAL ADDRESS, in which he reviewed the work of the past year, and urged the members to renewed energy and work, so as to maintain the standard of excellency already attained, and to surpass it if possible.

ORDINARY MEETING

Held in the Free Library, on Monday, December 2nd, 1895, the President (Mr. T. R. Connell) in the Chair.

The evening was principally devoted to an inspection of an interesting exhibition of objects of geological interest, collected by members during the past year, which included the following:—

A Series of Photographs of the scene of an Avalanche which fell in Switzerland, showing the district before and after it fell. These were exhibited by the Secretary on behalf of Rev. C. H. James who visited the district and photographed the place.

Petrological Microscope and Slides, also a newly constructed Goniometer, exhibited by Mr. R. W. B. Roberts.

Microscope and Slides, exhibited by the Secretary.

Rock Specimens and Minerals from the Auvergne district, exhibited by Mr. J. R. Thompson.

Views of American Scenery, shewn by Mr. J. Giffen.

Collection of Silver and Gold Ores, by Mr. D. Clague.

Views of British Coast Scenery, by Mrs. E. Clague.

Coal Measure Fossils from Wigan, by Mr. G. A. Haworth.

Mr. Craine sent cores from the boring at Knock-e-doon, Isle of Man, from a depth of 890 feet.

Several members gave a description of their exhibits, and Mr. W. Owen read a short Paper on some Glacial Deposits which had recently come under his notice.

"NOTES ON THE GLACIAL DEPOSITS NEAR WAVERTREE."

By William Owen.

During the last few months a number of workmen have been busily engaged sewering a strip of land which runs along the south west side of the L.N.W. Railway from Well-

ington Road to Sefton Park Station. During the progress of their operations some interesting geological features have been exposed. The sewer is, for the most part, cut through the Glacial deposits, and is an extension of the sewer to which Mr. Potter referred at our last meeting, when he reported that the boulder clay resting against the bare face of the rock, which forms one side of the great fault, which extends in a northenly direction from Otterspool by Wavertree, Stanley, Tue Brook, and Fazakerley, and which brings up the Pebble Beds to the same horizon as the upper soft red sandstones of the Bunter. The boulder clay near Wellington Road is about 18 feet thick, but increases in thickness somewhat rapidly as it approaches the line of fault. The clay is highly arenaceous in its composition, with numerous boulders of all sizes, from the size of small marbles to large blocks 18 inches or more long; they are derived from a variety of different rocks, and brought from many different and widely separated localities. The colour of the clay is bright yellow when first cut, but turns to a reddish brown when dried in the open air and exposed to the action of sunlight; it is mottled in a most singular manner with long streaks of light blue to olive green tints, which turn to a French grey when dried in the air. The coloured portion would average at least $\frac{1}{3}$ of the whole mass. When looking at a vertical section of the bed it appears to be roughly laminated, but the singular thing about it is that the lines of lamination run in a vertical instead of a horizontal direction, as if the bed had been tilted up on end. On closer examination, however, it becomes obvious that the bed has never been disturbed at any time since its deposition, and that the apparent lamination has nothing whatever to do with stratification.

The long streaks of colour, which at first sight give the impression of lamination, are due to the decomposition and decay of certain boulders, fragments of indurated and partially metamorphosed rock, probably from the Cumberland district,

or some other northern source. They are somewhat lenticulur in form and mostly packed on their edges, with their major axes in one general direction, so that when a section is cut through the bed parallel to the minor axes of the boulder, it has the appearance I have just attempted to describe, but when cut parallel to the major axes of the boulder it has a very different appearance. The coloured portion then takes the form of a more or less rounded oblong patch, and the difference in the appearance of the two sections is similar to the difference in the appearance of the figure on the face and edge of a dressed piece of figured oak.

The colouring matter is, I presume, a proto-salt of iron. In the case of the yellow clay it is probably ferric sulphite, whilst in that of the blue clay it may be ferrous sulphate, and the change in colour in both cases is the oxidation of the salt. The chemical action, resulting from the decomposition of the boulders, produces a pigment so potent as to penetrate and stain the clay, in some cases three feet or more in a downward direction, and it is highly probable, that in the same way and by the same process, the masses of blue clay so frequently met with in the boulder clay, has been coloured, only in this case the boulders are not sufficiently numerous or not sufficiently decomposed to colour the whole mass.

The curious and interesting feature of the boulders being arranged on their edges, is a clear indication that the beds were subjected to considerable lateral pressure during the period of their deposition, and as the pressure increased, there would be more or less flow in the direction of least resistence, and in the process the boulders would naturally assume a position so as to bring their flat surfaces at right angles to the direction of the thrust, on precisely the same principle that slaty cleavage is set up in older rocks. But what makes these facts so interesting and instructive is, that the very conditions calculated to bring about such a state of things

are clearly and unmistakably to be seen in the immediate vicinity.

The workmen, in driving a branch drain at nearly right angles to the main sewer, cut across a large bed of well-rounded but not striated pebbles, interstratified with coarse gravel and sand, with a plentiful sprinkling of sand-encrusted clay boulders. The bed is about 20 yards wide, and its presence is indicated at the surface by a long ridge raised slightly above the surrounding land, and sloping off on either side in gentle declivities, it has an easterly and westerly trend, approximately parallel to the course of the Mersey. I cannot ascertain how far this ridge originally extended, because on the west it has been levelled off and houses built over it, and on the east it is covered by the railway embankment, while across the centre a small stream has cut its tiny valley. It is most probable that when first formed, it extended right across the low lying land which intervenes between the elevated ground of Edge Hill and Mossley Hill.

Now there can be no question as to the fact, that we have in these beds of sands and gravels, and this ridge of pebbles, an old raised sea-beach, and which, I have no doubt, might be easily correlated with one or other of the many similar raised beaches in this and other districts, such as the examples we saw at Cefn and the Vale of Clewd. On examination it is found that a large proportion of the pebbles are derived from the Bunter and Keuper sandstones of the immediate district, and the remainder similar to those found in the surrounding boulder clay. These facts go far to prove that the marine denudation going on when this old sea-beach was formed, was very much analogous to that which is now proceeding along the south shore from Dingle Point towards Garston, a low sandstone cliff with a thick superincumbent bed of clay, as denudation proceeded, the clay was washed out, carried away, and re-deposited on the sea floor, whilst the boulders remained and mingled with those formed by the breaking up of the sandstone cliffs.

In this ridge of pebbles there can be little doubt that we have a most interesting local example of a Scotch "Kame"—a ridge of boulder, pebbles, gravel and sand, cast up above high water mark by the action of the waves along an open sea beach. We can see many such ridges in course of formation along the Welsh coast at the present time. The finest example, with which I am acquainted, is the "Nugal Sands" in St. Bride's Bay on the west coast of Pembrokeshire. The Bay is a deep indent in the line of coast, eaten out of the soft rocks of the coal measures by the insatiable maw of the all-devouring Atlantic. It is flanked on either side by hard igneous rocks which have resisted denudation, and stand out in bold promontories. The cliffs in that locality, except where the coal measures run down to the seaboard, consist of igneous, Silurian, and altered Cambrian rocks, against which the restless waves of the heaving and rolling Atlantic urge an incessant warfare, and in the strife many large and small fragments are ever and anon struck off and fall to the shore beneath, where they are pushed and rolled backwards and forwards by the tides and currents, until, at length, they become rounded, smoothed, and polished; then "when the west winds blow" and "the grim visaged fiend of the storm" has lashed the breakers into fury, large numbers of these rounded fragments are cast up high and dry. It would seem that old Neptune considers these fragments as aliens and intruders, and in his rage and fury hurls them headlong out of his watery domain, where they accumulate in an enormous ridge along whose crest the high road from Haverfordwest to St. David's runs for a considerable distance.

Now, this ridge of pebbles at Wavertree, though not perhaps on so grand a scale, has been formed and accumulated by the same means and in the same manner as the "Nugal Sands." When the land was emerging out of the water, after the great submergence of the Glacial Period, the elevatory movements were not constant, but intermittent—there

were seasons of activity and long periods of rest—there is abundant evidence of that fact in the Glacial deposits,—and it was during one of those protracted periods of rest that the marine denudation took place which formed the sea beach upon which this ridge of pebbles was piled up, and I have no doubt that it was during this lengthened period of denudation that much of the Keuper beds, which once encumbered the upper soft red of that locality, were worn off and removed.

I will now very briefly consider in what relation this ridge of pebbles stand to this singular bed of clay, with its peculiarly arranged boulders. I have said that their peculiar arrangement indicated great lateral pressure, and hinted that the proximity of the ridge of pebbles furnished a key for the solution of the problem as to the position of the bed and the arrangement of its boulders, and in order that the conclusions may be sound and logical, I will restate a few of the facts before I attempt to draw any inferences from them. 1st. there is the ridge of pebbles, 2nd. there is the bed of clay lying up against the north side of the ridge, 3rd. in the bed the boulders are packed on their edges, with their long axes in one general direction, 4th. the long axes of the boulders are parallel with the long axes of the ridge, 5th. moving land-ice has passed over the Liverpool district, and in conjunction with these local facts one general fact must also be stated. When moving ice comes in contact with an immovable body, the debris which the ice is carrying along with it accumulates at the back of the obstacle, and forms a hard slope up which the ice moves, until it surmounts and passes over it.

Now then for the explanation of the geological phenomena of the ridge, the clay, and the boulders. In my opinion, it is almost certain that, during the time this ridge of pebbles was accumulated, this country enjoyed an interglacial period, when its climate became almost as mild as it is at the present time, but at its close, glacial conditions again set in with great rigour; at first, the Highlands of Scotland, and north

England, became covered with ice, and glaciers flowed down the valleys, and as the ice accumulated a thick sheet of it spread out over the adjacent country, and continued to flow southwards until at length it invaded the shores of the Mersey. When the ice had travelled so far south as Wavertree, it collided with our ridge of pebbles, and as the ice was comparatively thin at first, it had not sufficient force or momentum to remove the ridge, so it proceeded in the usual way, the debris was packed up against the north side of the ridge with increasing pressure, until it formed a hard slope up which the edge of the ice crept and so passed over.

Now the ice would be flowing due south, and as the direction of the ridge is north east and south west, lines passing through their respective axes would not form right angles, there would be an acute and an obtuce angle, so that when the ice came in contact with the ridge, there would be a slight flow of the debris in the direction of the obtuce angle, and this flow under the great pressure would be the efficient cause of the boulders being arranged in the order in which we find them. So that I think I am warranted to infer from the facts that the ridge of pebbles was accumulated on an open shore by the action of the waves, the bed of clay formed the slope by which the ice sheet passed over the ridge, and the flow of the clay during its deposition accounts for the peculiar arrangement of the boulders.

ORDINARY MEETING,

Held at the Free Library, Monday, January 6th, 1896, the President (Mr. T. R. Connell) in the Chair.

Mr. B. Conlan occupied the evening with an optical lantern exhibition of views possessing much geological interest, shewing successional scenes in Devonshire, Orkney, Norway, Spain, Switzerland, Italy, Malta, North America, New Zealand, and South Africa, being a panoramic tour round the world, especially illustrating the work of denudation, both marine and subæreal.

A free conversation took place while the pictures were being exhibited; and afterwards, in passing a vote of thanks to Mr. Conlan, the hope was expressed that we should soon have a continuation of the work.

ORDINARY MEETING,

Held at the Free Library, Monday, 3rd February, 1896, the President (Mr. T. R. Connell) in the Chair.

Mr. R. W. B. Roberts, F.G.S., read a short paper on an interesting rock specimen found in the collection of Australian minerals, sent by Mr. R. T. Litton, F.G.S.

"NOTES ON AN AUSTRALIAN SPOTTED SHALE,"

By R. W. B. Roberts, F.G.S.

In the collection of Australian minerals presented to the Liverpool Geological Association by R. T. Litton, Esq., F.G.S., Sydney, was a specimen of soft, light-brown shale, with numerous oval, black spots. With the object of determining the nature of these spots,—whether organic or inorganic,—several sections of the shale were prepared for examination under the microscope. The shale was then seen to contain many very fine grains of quartz and light and dark micas, the lath-shaped sections of biotite being the most prominent.

The spots appeared reddish-brown in colour, were much finer-grained than the rest of the shale, and mostly showed a nucleus somewhat darker than the rest of the section. In order to ascertain whether the colour of the spots was due to the presence of carbonaceous matter, an oxidising blowpipe flame was directed on several of them. By this means any carbon present would have driven off as carbonic acid gas. Only one or two of them changed from black to brown; the others did not appear to be affected at all. That proved that although carbon was there in small quantity, yet the colour of the spots was not altogether the result of its presence. There seems to be every reason for believing them to be incipient or imperfectly developed crystals of staurolite or andalusite, resulting from segregation promoted presumably by contact metamorphism. The development of oval spots in shale or slate as an early stage in the formation of sporadic crystals has been observed in several localities, and in the knotenschiefer and fleckschiefer, or spotted slates of Germany, we have probably the same phenomenon illustrated. What is remarkable about the Australian specimen is that it does not bear any traces of the induration we might naturally expect to accompany the formation of crystals.

The first part of a paper, written by Mr. F. J. Spence, M.E., of Adelaide, Australia, on "The Broken Hill and Barrier Minerals," was read in the absence of the author by Mr. D. Clague, F.G.S.

Exhibits.—Iron nodules from the interior of a sigillaria, from Moss Pit, Ince, exhibited by Mr. G. A. Haworth.

ORDINARY MEETING,

Held at the Free Library, Monday, 2nd February, 1896, the President (Mr. T. R. Connell) in the Chair.

After the usual business had been done, the Secretary read some notes on "The Nitrification of Soils," which he illustrated with views shewn by the lantern.

"NOTES ON THE NITRIFICATION OF SOILS,"

By W. Scott-Walker.

Of late years, students in every department of science have become interested in "Bacteria," as the various forms of micro-organisms are popularly called, and geological students are no exception to the rule, as various forms of Bacteria are now found to act on both rocks and soils.

For a long time it was a problem how the organic constituents of the soil were converted into nitrates so as to be useful as plant food; then again it was known that some plants obtained a supply of nitrogenous food, quite independent of anything contained in the soil, yet it was well known that they had no power to assimulate free nitrogen, nor yet to produce such a combination of nitrogen with other substances as would supply them with it in proper form.

1.—I will first consider the question: how organic compounds of nitrogen, such as exist in vegetable and animal remains, are converted into nitrates for the use of plants.

In the year 1877, two French chemists, Schloesing and Müntz, proved that the change was due to the action of micro-organisms. Many investigators worked at the subject in order to find the particular organism, but it was not until 1890 that it was discovered by an Englishman, Dr. Percy Frankland; it was also discovered independently by Winogradsky, a Russian investigator, who found that it could subsist on purely mineral food.

Much of the knowledge which we possess of Bacteria has been gained from a study of them when grown artificially in some nutritious media, but it was found that the Bacteria in question could not be cultivated in any of the ordinary media.

After Frankland had isolated them, he found that they only produced nitrous acid (HNO_2), whereas the nitrates are salts of nitric acid (HNO_3). The researches of

Warrington and Winogradsky have now shewn that there are two sets of organisms at work—one producing nitrous acid, the other converting nitrous into nitric acid.

In this connection an interesting question is suggested to the thoughtful geologist, as to whether the enormous beds of nitrates found in Chili and Peru owe their nitric acid to the action of these or similar organisms.

2.—The problem of how certain plants obtain a supply of nitrogen, greatly in excess of that which is in the soil itself, has been solved by two Germans, Hellriegell and Willfarth. At present we only know of one order of plants which receive this extra supply, the Leguminosæ, such as peas, beans, clover, &c. These investigators have shewn that it is due to certain Bacteria living in and around the roots of these plants, that are capable of fixing and combining the free nitrogen of the atmosphere which is in the soil, and once the nitrogen is combined it is now easy to trace the method of its conversion into nitrates as suitable food for the plants.

These organisms cause peculiar growths or swellings, technically called nodules, on the rootlets, therefore, although we cannot see the Bacteria with the naked eye, we can easily find the nodules on the roots of the legumes, so proving their presence.

Small as these Bacteria are, only looking like little dots when studied under the microscope, it is clear that there are many varieties of them, for each variety of the Leguminosæ has its particular Bacteria which thrives upon it, while it will not thrive upon another member of the same order.

Much has yet to be learned respecting these Bacteria and their work, but it is interesting to know that the French chemist, M. Müntz, has found them on the bare rocks of mountain peaks, and attributes to them a considerable share in the breaking down of rock masses into soils.

Mr. G. A. Haworth exhibited a stalactite of salt, (chloride of sodium) which he had obtained from the roof of a coal pit 730 feet below the surface.

Mr. R. W. B. Roberts exhibited and described some coal measure fossils which he had recently obtained.

The rest of the evening was devoted to an examination and study of Australian minerals, which included gold and lead ores belonging to the Association, silver, lead, copper, and iron belonging to Mr. D. Clague, F.G.S., from South Australia and New South Wales, and gold, iron sulphate, copper sulphate, and native alum from Queensland, belonging to Mr. S. Davies, Asso. San. Inst.

On Easter Monday, April 6th, 1896,

A FIELD MEETING

was held in the district of Rhydmywn, near Mold, conducted by Mr. F. J. Lloyd.

A visit was first made to the East Halkyn Mine, where the ores brought from the mines were examined, principally galena and blend, the process of crushing, cleaning, and sifting, being explained by the attendant. A few of the more adventurous members descended the mine to see the ore in situ, others went on a little further to see another mine, securing specimens of calamine. Subsequently a visit was made to the limestone quarries, various points of interest being noted and characteristic fossils obtained, principally corals and producta.

ORDINARY MEETING,

Held at the Free Library, Monday, May 4th, 1896, the President (Mr. T. R. Connell) in the Chair.

NOMINATIONS.—Mr. J. W. Dunn, 52, Hatherley Street, and Miss E. Brown, 62, Bianca Street, Bootle, were nominated.

COMMUNICATION.—The Secretary gave a report of the Field Meeting at East Halkyn Mine, which was supplemented by remarks from other members.

A Paper was read on

"THE OLD RED SANDSTONES OF PEMBROKESHIRE."

BY WM. OWEN.

FIELD MEETING, WHITMONDAY, 25TH MAY, 1896.

This was held at the Works of the Cambrian Silver-sand and Limestone Co., Ffrith, near Brymbo. After a visit to the quarries from which the sand and limestone are obtained, the works were visited and the methods of preparing the raw material for the market were studied. The return walk in the Ffrith Valley along an escarpment of limestone, enabled the members and friends present to study in some detail the salient features of that formation.

ORDINARY MEETING,

Held at the Free Library, Monday, June 1st, 1896, the President (Mr. T. R. Connell) in the Chair.

ELECTIONS.—Mr. J. W. Dunn and Miss E. Brown were duly elected members.

NOMINATION.—Mr. Frank Young, 84, Salop Street, Kirkdale, was nominated for membership.

EXHIBITS.—Mr. White exhibited an amygdaloidal rock, asking information respecting the white mineral filling the cavities. The President exhibited boulders, gypsum, and shells from the boulder clay at Dawpool. The Treasurer, a series of photographs taken at Ffrith on Whit Monday.

The following Paper was then read, and illustrated with specimens.

"HOLIDAY STUDIES OF A GEOLOGIST."

BY D. CLAGUE, F.G.S.

The course of events were so directed that the writer landed at Bangor one fine summer day bent on rest and

recreation, at the same time being on the alert in the interests of his favourite science, to see it in all its various facies, seeking not after new discoveries so much as new illustrations of old well-known truths, and asking nature to tell her own story in her own way. Not ignoring the work of other labourers in the same field, but after reading their works and studying their teaching, to hold the pictures they had painted side by side with the originals in the field to judge if they be faithful portraitures, and thus in holiday time and holiday spirit learn, it may be, new truths but certainly be made to feel that the old truths often repeated are living realities.

In this spirit then he sought and obtained lodgings at Calleppa, the highest part of Bangor, equally convenient for the ferry on one hand, and the railway station on the other, at the same time he had but to leave his lodgings by the back door, pass through "mine host's" garden, and in a few minutes reach the greatest elevation of Bangor Hill, and so obtain a bird's eye view of the district, with Anglesea beyond the Straits; there he sat, and with a map of the district spread out, plotted out some geological holiday work for the few days he had to spare.

In pursuance of a plan thus laid out a railway trip across Anglesea was undertaken, map in hand.

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After crossing Menai Bridge we passed through a few miles coloured in the geological map as pre-Cambrian schists. At Holland Arms Station the land was flat and somewhat marshy, with a coal pit at hand, indicating the geological formation; passing along, the rich green of the grass and a lime-kiln close to the railway indicated a limestone formation; soon the ground became somewhat hilly again, a cutting near Llangefni showed clay schist similar to that we had already passed through—between Menai and Caerwen—from that to Llanerchymedd the ground was decidedly a flat land with hummocks breaking through the flatness here and there.

This district is marked on the map as composed of granite. From Llanerchymedd to Rhosgoch, gentle undulation indicated the surface marked by the survey as Llandeilo. In walking over the same ground on returning, these undulations engaged special attention as the road passed directly over the summit of several of them. In one case, 4 minutes brisk walk brought us from the commencement to the highest part, which was 50 feet above the plain, and 4 minutes more brought us to the level again, in another case, 7 minutes were required to reach the top, which was 80 feet above the plain, gradually the undulations became more abrupt, and passed into the hummocky character seen from the train on the outward journey. Such hummocks have been described in our Journal, Vol. 8, p. 44, as occuring in the limestones near Port S. Mary as small domes, like miniature volcanic cones, and the hope is there expressed that someone will confer a benefit upon our science by explaining their origin. Well right in front there is one dissected, evidently some body has wanted stone and has quarried into the dome-like mass of rock, it is found to be an upthrust of porphyrite which has elevated the shaly and schistoze matter which encloses it into the dome-like boss.

Llanerchymedd is passed—a turn in the road—we pass a new church, we reach a place named by a resident as Coade Cardara. There is spread before us the scene which was thus described by Sir A. Geikie, LL.D.

"The very external features of the ground recall the peculiar hummocky surface which so persistently characterises the areas of this rock (Gneiss) from the far north of Scotland to the west of Ireland. If the geologist could be suddenly transported from the rounded rocky knolls of Sutherland or Galway, he would hardly be aware of the change, save in the greater verdure of the hollows which has resulted from a more advanced state of decomposition of the rocks at the sur-

face, as well as from a better agriculture." Presidential address, 2. J.G.S., 1891, p. 83.

I found it difficult to learn the character of the basal bed, as no sections were visible and time did not allow any lengthened search; in places however, it was clear that the high road was cut in solid rock, and that instead of having been made by the addition of new material it was made by levelling the rock in which it was cut. On clearing away the loose material it was readily seen to be a fine grained gneiss, in some places scarcely distinguishable from granite. I could not secure a specimen myself, but have recently received one from a friend who was more fortunate.

Several of the bosses or hummocks have been partly quarried, and an examination of them showed a variety of intrusions, one seems to be a pegmatite or a felstone, another proved to be an intrusion of hornblende rock.

I have already intimated that Sir A. Geikie noted the physical resemblance of the Anglesea scenery with that of Sutherland and Ross, and when we learn that he correlates them as of the same age, the *Fundamental gneiss* of Sir R. Murchison, and the lowest of the pre-Cambrian rocks which he (Geikie) has called *Archean*, our interest in them becomes intensified, at least it was so in my case, as I walked slowly over this basement bed, the foundation zone of the British Islands, and passed in review the numerous cycles and ages which have rolled by since these rocks were formed, with their succession of life facies which have culminated in the world as we now know it; nor would one's thoughts be still, and questions such as What went before? What lies below? were asked but never answered. In N. W. Scotland the thickness of these beds is not known, but must amount to at least 20,000 feet (Geikie). In North America the Laurentian Rocks which are supposed to represent the British Archean are calculated to be at least 30,000 feet thick, but the base has

not been found. In India, the Bundlekund, representing these rocks, also has not been penetrated. In New Zealand, the gold bearing schist of Otago, 50,000 feet thick, rests on a crystalline gneiss, the lower margin of which has not been seen.

Of the conditions under which they were formed, little can be learned. Geikie wisely says, "So far as present knowledge goes, the Lewisian gneiss of the north-west Highlands of Scotland was originally a mass of eruptive rock, which has subsequently undergone a succession of deformation from enormous stresses within the terrestrial crust. The alternation of rocks of different petrological constitution, suggest a series of extravasions of eruptive materials, though it may be impossible now to determine the order in which these followed each other."

* * * * * *

Another day (20th August, 1895), crossing Garth Ferry, a quiet walk along the Beaumaris road, opened out another set of rocks equally interesting. It was a beautiful walk; on the left, rugged rocks towered upwards, surmounted with trees; on the right, the ground sloped down abruptly to the water, the slope covered with luxuriant vegetation, including trees and under brush—now shutting out all sight of the world beyond, like an Eden alcove, now an opening amongst the trees enabled one to get a glimpse of Beaumaris Bay with the rugged side of Penmaenmawr, then little peepholes amongst the branches enabled us to see Bangor and the pleasure grounds behind. The walls on the road side were laden with mosses and ferns growing in the niches and cavities, polypody and wall rue were specially abundant. At Baron Hill grounds the rocks formed an interesting study, first there was grey clay schist, very much contorted; here dipping 30° S. by E., and only a few yards away the dip was 45° S. Suddenly faulted against green (chlorite) schist, also much crumpled, this ended abruptly against clay schist, this alternation was many times repeated, I found it so interesting that instead of going

further on the Beaumaris road I dropped down to the shore to study these same rocks at a lower level (say 30 feet). On the shore cliff I saw very little clay schist but an abundance of chlorite schist, and from this cursory view, I should infer that the chlorite schist is the older rock overlaid by the clay schist, and that they have been brought to the same level by a series of faults which were apparent on the road but more so on the shore, and came to the conclusion also that there are a greater number of small faults on the upper horizon than on the lower, but the lower ones were more marked, this accords with Mr. G. H. Morton's view of the faults of the Trias.

This patch which interested me so much, is but one of a series of metamorphic rocks found in different parts of the Island. On the north, we have them from Dulas Bay to Carmel Head; on the west, from Church Bay to Holyhead Island; in the centre, from north of Llangefni to Aberfraw. The patch which engaged my attention is represented as extending to the north-west, to Red Wharf Bay, and southwards to Maldreath Bay. Not all of the same rock however, for one of the most conspicuous members is quartzite, which forms the most prominent mass of Holyhead Mountain, chloritic slates, green and purple phyllites, and bands of grit, I did not see all these in situ, but all were represented in the rough masonry of the walls and houses.

Sir A. Geikie says of them, "No one familiar with the *Dalradian* rocks of Scotland and Ireland, can fail to be struck with the close resemblance which these younger schists of Anglesea bear to them even into the minutest details. Petrographically they are precisely the counterparts of the quartzites and schists of Perthshire and Donegal, once thought to be altered sediments of Silurian age, are now shown to be pre-Cambrian, and constitute the second of these

formations, consisting in Scotland of quartzite, limestone, clay slate, and graphite schist; in Ireland, the rocks of this age are similar in character.

This covers a great area, extending as it does from the Moray Frith through Argyleshire to Donegal, Mayo, and Galway, an extent of not less than 400 miles.

Now that we have brought before us the most ancient rocks known, we may leave Anglesea to note the pre-Cambrian rocks in other places.

* * * * * *

It was in August, 1893, we paid a visit to the Wrekin, a most interesting spot, the relic of a pre-Cambrian volcano. The Wrekin is one of a range of four hills, separated from each other by narrow valleys or gorges, at the bottom of each there still flow streams of water, the natural eroding agent which has cut up the original mound into four, and which still keeps sawing away with eternal grind.

The range comprises Ercal Hill, the most interesting features of which are:—

1. A dyke of red granitoid with grey rhyolite, said by some writers to be intrusive in the red, I could see no evidence of that, though I searched for it, nor yet could any of the company, but I did pick up many fragments, some red enclosing grey, some grey enclosing red, some grey on one side and red on the other, some all grey, some all red, but a junction in situ could not be found.

2. On the south side of the hill we had a mass of quartzite, in which the rounded grains of sand may in some cases be distinguished, and tiny crystals of quartz glitter in the sunshine on the planes of stratification.

A quarry on the south side of Laurence Hill shows the general character of the rock of which the range is composed. Volcanic ash, in some places highly indurated, again decomposition set up produced layers of bole, again the ash in some

places contains much calcite, and an occasional vein of pitchstone, more or less de-vitrified, all indicate very clearly the volcanic character of the rock.

When I add that the rocks so far studied dip to the north at an angle of about 40°, along the east side the dip is to the east, and in Primrose Hill to the south of the Wrekin, the rocks of the same general character dip to the south, we not only see that the rocks are volcanic, but are led to look on the Wrekin Hill itself for the remains of the old volcanic neck. I think we discovered some direct indications of it. Ascending from the north side we saw the rocks dipping to the north, on the east we saw they dipped to the east, and at the south they dipped to the south. On approaching the south end of the Wrekin we observed indications of a compact igneous rock having a columnar structure. The columns were horizontal and radiating to the north east and south east, so converging towards one point which I assume to be the centre of the neck, and a line drawn round the outer ends of these columns would indicate approximately the boundary of the neck. I assume this to be the case on the principle that the columns of cooled igneous rock are arranged at right angles to the cooling surface. On the west side the whole range of hills has been cut through by a great fault, throwing these pre-Cambrian rocks up to a considerable elevation above the Triassic sandstones which extend across the plain to the west. This patch of old rock which rises like an island above the younger rocks around it, belongs to the later of the three formations of pre-Cambrian age called by Dr. Calloway *Uriconian*. Of similar age are a number of similar protusions, *e. g.*, Pontesford Hill, centre of the Malvern Hills, Twt Hill, Charnwood Forest, and St. Davids.

These pre-Cambrian rocks have long been supposed to be unfossiliferous, indeed, some writers have called them Azoic, indicating by the very name that they contain no relic of

past life, that, in fact, when they were formed the world was "without life," and it would be strange indeed if they contained fossils in anything like the state of preservation we see them in the Lias or Crag rocks, seeing that they are much older and have been subject to more strain and have been much altered, still we are not without indications of the existance of life on the globe even at this early period.

In the quartzite of the Wrekin there are found some markings which are assumed to be worm burrows, in the quartzite of Anglesea they have been found, and also in the quartzite of Sutherlandshire, and according to Sir A. Geikie traces of corals and graptolites have been discovered in the Dalradian rocks of Donegal.

ORDINARY MEETING,

Held at the Free Library, on Monday, July 6th, 1896, the President, Mr. T. R. Connell, in the chair.

ELECTION.—Mr. F. Young, of 84, Salop Street, was duly elected.

EXHIBITS.—Mr. Haworth exhibited some splendid Sigillaria from Wigan coal field, and Mr. Clague showed some fossil annelid tracks and fucoids from the Isle of Man.

Mr. Barr then read an interesting paper of which the following is an abstract:—

"FROM THE MERSEY TO THE SEVERN ON A BICYCLE."

BY W. B. BARR.

[ABSTRACT.]

When I took this trip it was for the purpose of obtaining a change from everything connected with the serious business of life, and gaining the pleasure of wheeling through an

unknown country, with a vague and indefinite idea in my mind to note any striking geological features or objects of interest on the road, but I never for a moment dreamt of committing to paper any of my bicycle experiences; having been unexpectedly requested to write a paper on recollections of this trip, I have done so, feeling that it is a very rambling affair, with very little geology in it and probably some few errors. I therefore submit my remarks to your good natured criticism.

The Severn and the Mersey are in many respects alike; both are level rivers, both are richly endowed with sand deposits, in the near neighbourhood of coal fields, centres of great populations, scenes of marine and sylvan beauty, and on their waters the navies of the world can ride. Leaving the Mersey at New Ferry we note that the Cheshire side of the Mersey is interesting in affording many studies in the sandstone formations, ripple marks, foot prints, water beds, also its splendid marine forest remains, rich boulder clays, worn rocks, glacial markings, and sand dunes.

Passing along the Chester road we come to Bromborough Pool, which would repay a visit from some of us,—tracing it from the mouth and inland. The country on to Chester is fairly flat; near Blackford we noticed a large sand pocket amid clay surroundings. Chester, the shrine of many pilgrims, the home of the antiquarian, has also some good sandstone exposures along the canal, also in the railway cuttings; the river Dee has also a story to tell, not only of denudation, but also of the re-making of the land, which process, aided by the hand of man, has turned out successful and perhaps profitable; we would like to see it carried out more extensively further down the river, for to gain land is good for all time, and always good for taxes.

After duly refreshing, we were fain to leave this very popular city, and in due course were on our way again through

the Vale Royal, celebrated in all ages for its rich pastures and agricultural lands, and arrived at Rossett. The view from here, looking back over the Vale Royal, is truly noble and worthily named *Royal*. We now wheel through Gresford, with lofty trees, hilly ground, parks and mansions, and cross the border into Denbighshire.

After leaving Wrexham the scenery is uninteresting until we reach Overton, situated in Flint on the winding banks of the Dee; both banks are very precipitous, but towards Bangor-e-coed the river becomes shallow with low pasture land on each side, here we have a delightful peaceful park like country, also affording an illustration of the well known sentence: "Hard, gorge; soft, valley."

A smart run of a few miles brought us to Ellesmere in Shropshire. The mere is a beautiful glassy sheet of water nearly one mile long and covers 150 acres; the land rises abruptly all round and it seems but the bottom of a much larger lake. There are four other smaller meres close to. We were much pleased and would liked to have stopped some time and explore round, but circumstances required us to urge on our way to Salop.

The second day found us passing through Shrewsbury which stands upon an elevation; extensive quarries are close at hand. Here we come in touch for the first time with the Severn, something similar to the Dee above Chester.

Continuing our way southward we noticed on the left that notable mass of igneous rock, the Wrekin, 1,520 feet above the sea, about one of the first volcanoes of Britain. Twelve miles further on the right will be seen a good section of conglomerate and red marl; hitherto we have been wheeling over the Triassic, but now we are on the Silurian and with it comes change of scenery at Church Stretton, this is the classic ground of geology, Caradoc and Wenlock Edge are on our left, the

Longmynd and Stiperstones on the right. This little village is nearly all hotels and inns, a most picturesque spot, nestling directly below and on the steep sides of the Longmynd, which, with its deep gullies and cross valleys forms an important range of hills in Shropshire, rising from 1,400 to 1,600 feet.

Murchison says: "This semi-mountainous mass is found to be composed of the most ancient recognisable sediments of the British Isles. Ranging N.N.E. to S.S.W. they stand boldly out from beneath the silurian deposits of which they form the stony acis. The lowest strata of the Longmynd range along the Western side of the Stretton valley. Quartz veins occur here and there,—but on the whole, these strata consist of sandstone rock, often finely laminated in which the lines of deposit and even the rippled surfaces of the beds are distinctly visible,—the mass is scarcely affected by any slatey cleaving."

"For many years the beds of the Longmynd were believed to be utterly unfossiliferous, but Mr. Salter found eventually in them traces of fuci, some annelid or worm tubes, and a portion of a trilobite named Palæopyge. On the west flanks of the Longmynd which extends into Montgomeryshire is a very symetrical ascending order of strata from the Cambrian rocks to those of the Silurian; but on the east or Church Stretton side there is a great fault, estimated by Professor Ramsey at not less than 2,000 feet, the place of the intervening strata being taken by igneous rocks. We find, therefore, that the Caradoc range, as it is called, consists of igneous and altered rocks, for the eruption having taken place after the deposition of the sediments, has altered the shales into clay slates and the sandstone into quartz rock. The only portion which has escaped the effects of this fault is a small patch of upper Silurian, or Wenlock limestone, that occurs at Botville, a little higher up the valley, and is curiously wedged between the Cambrian rocks of the Longmynd and those of the Caradoc group."

"The Stiperstones lie further west and nearly parallel with the Longmynd. These strong masses appear to the artist like isolated cyclopean ruins jutting out upon a lofty moorland ridge at heights varying from 1,500 to 1,600 feet above the sea. Looking west, from the top, the hills slope rapidly and beyond it is a picturesque, hilly tract, the strata of which are laden with lower Silurian fossils and diversified by a variety of rocks of igneous origin. The Stiperstones are outstanding fragments of a thick band of silicious sandstone, in parts veined, altered and fractured and occasionally passing into quartz rock, they yet form an integral portion of the outlying schistose formation, while fragments of the shell lingulæ occur in them."—*Siluria.*

Onward again we roll under a blazing sun through a narrow valley, the sides of which are covered with trees; through the World's End. The valley now broadens,—we dash through Craven Arms where we see nothing particular except an old castle; turning to the left we cross the river Onny, from here to Ludlow the country is wonderfully charming. Before reaching Ludlow the road falls rapidly until we cross the river Corve, soon after we have to dismount from our machines and push them up a rising hill on which the ancient town of Ludlow is built. It is a pretty, clean and select sort of place; conspicuous is the old castle and abbey buildings,—the view from here looking northward is grand and varied; the parish church is worthy of anybody's best attention. This locality in olden times must have been a pretty warm place, judging by the number of castles which environ it. To the geologist it is specially interesting, a few facts may be acceptable. To the east rises the Titterstone and Clee Hills, some 1,754 feet high. The coal field of the Clee Hill is particularly interesting, from the fact of its having been pierced by an outburst of basalt, which has spread over it and forms the basaltic head of the Titterstone Clee. The coal seams, two or three in number, are nearly horizontal, and the shafts by which they

are reached pierce the basalt. It is curious that of all these coal fields none of the beds rest on grit or limestone, owing to their absence. In the case of the Clees, the coals rest on the Old Red, but on the north and west sides of the hills are both grit and limestone, the latter, at Oreton and Farlow, being the equivalents of the yellow sandstone, and abounding in fish remains, such as Pterichthys Macrocephalus, while the overlying limestones are rich in palatal teeth of Orodus, Pœcilodus, Helodus, &c. On these hills the archœoligist and the botanist can have a good time.

Before leaving Shropshire, which we do most reluctantly, we note that at Church Hill, Leintwardine, the first fish was found,—Pteraspis Banksii, in 1859, also that the bone beds in the upper Ludlow, commonly called "Ginger Bread," a mass of bones, teeth and scales of fishes are to be seen at Lulford Lane, on the slopes of Whitcliff, and at Norton, near Ludlow.

At 7 p.m. we leave Ludlow, having to walk our bicycles down a steep hill, through a huge gateway, across its ancient and curious bridge, up another sharp slope to the fairly level plateau, and here we made a gallant rush for Leominster, if possible, before dark. The river Lugg, a considerable tributary of the Wye, intersects this road. We are now in Herefordshire.

Leominster, for a little town, is very ancient and important, also has played a gallant part in the history of our country,—founded by the Saxons, captured and destroyed by the Danes in 777, again destroyed, rebuilt, and much more of this sort of thing; it has a fine minster and remains of an old castle. We are now on the old red sandstone which will probably account for the nature of the trade of the town, nearly all of an agricultural character, such as products from cattle and sheep, hops, corn, &c.; no mining, except a stone quarry here and there. A good section of old red may be seen at Leyster Pole and Puddlestone, the bony plates of Scaphaspis and Cephalaspis (fishes).

Next morning we left the bustling little town, and after riding six or seven miles we had to mount Dismore Hill, our road leading right over the top; long ere we reached it we were glad to dismount and do a cheerful walk. The descent was much steeper and the road zig-zag. Next, the country was level, the farm houses were old fashioned looking, often quaint, so seemed many of the people,—long smocks worn by many of the men has not yet gone out of fashion. The soil generally is of a deep red. We passed our first hop garden, and a strange sight it looked to our northern eyes. Some writer, long ago, said, the people of Herefordshire and Gloucestershire grew their own vines and drank their own wines; this is not true now, but it is the land for good cider and plenty of it.

We now enter the county town, Hereford. This is really a pretty city, having the style of a cathedral town; the cathedral is a poem, we could have lingered in and about it for hours.

Herefordshire is a county where the poet may truly catch the divine afflatus. The county formed a considerable part of old Siluria, and it shares largely in the honours justly ascribed to that region by the poet Dyer:

> "Pleasant Siluria, land of various views,
> Hills, rivers, woods, and lawns and purple groves,
> Pomaceous, mingled with the curling growth
> Of tendril hops, that flaunt upon the poles."

Its eastern boundary is grandly marked to a considerable extent by the Malvern Hills; its western borders are still more grandly marked by the Black Mountains; a tract in the north-west contiguous to Wales and Salop; and a tract in the east, between the rivers Frome and Tame, consists of upper Silurian rocks. Iron was worked by the Romans; limestone is found at Ledbury, Aymestry, and Woolhope; and small quantities of fuller's earth, pipe-clay, and ochre occur in some parts, the rest of the county being nearly all old red sandstone which rise

to their highest beds in Brecknockshire Beacon, and in the escarpment of the Black Mountains is seen the finest exhibition in England and Wales of the old red sandstone rocks.

Travelling forward about twelve miles through a lovely country we reach the town of Ross, which stands well up on a great slope. It is much frequented by tourists and others and is noted for the fine views obtained from the new promenade.

We now commence the cream of our journey, and at night-fall reach the famous Symond's Yat. Next morning we ascended this hill, some 700 feet high. The view from the top beggars all description. In the distance all the adjacent counties are seen, also Goodrich Court and Raglan Castle, two notable gems among the famous castles of our land; the sinuous course of the Wye trails through the land like a broad ribbon, and passes and repasses 700 feet immediately below you. Symond's Yat stands almost by itself, divided from the neighbouring hills by deep gorge-like valleys whose sharp slopes are literally covered with tree verdure; looking towards Monmouth this description is specially applicable. The river flows towards this town and in its course there is a considerable rapid which may be navigated by specially qualified men. Looking still in this direction are seen huge masses of rock detached from the precipitous side, called "The Sisters"; the stranger might very easily mistake them for old, weird-like castles, moss and lichen covering most part with living green, leaving uncovered parts of a whitey grey colour. Here for some miles down the river we are on a bed of carboniferous limestone.

We must now leave this delightful spot and return to the village inn to settle up and get across our bicycles, as the day is far advanced and we have a long ride before us. On leaving the village we have a considerable hill to mount, after which the descent on the other side is of the prettiest description. At the bottom of the valley flows the limpid Wye, revealing

itself occasionally through the trees until we reach Monmouth, where the river widens out and soon afterwards contracts again.

The county town of Monmouth is uninteresting and we rode right through it, crossing by a rather good bridge on to the left side of the Wye. The road for miles runs close to the river, the land on each side rising several hundred feet and covered to the top with trees. Having again crossed to the right of the river we pedal on a few miles further and reach that well known ruin, Tintern Abbey. After a rest and tea we again resumed our journey. Here the road begins a long ascent, and at the top we reached the Wind Cliff from which are seen magnificent views stretching over land and sea. Darkness now set in and obscured further observation that day and we safely put up for the night at Chepstow.

The picturesque town of Chepstow is situated on the river Wye, which a few miles lower down enters the Severn. The town is built on the slope of a hill among lofty cliffs, and must have been esteemed in early times a very favourable position for military works. Considerable remains of a Norman castle are to be seen, also some portion of the wall which enclosed the town, small round bastions and an entire gate. The tide in the Wye here is higher than anywhere else in Europe, rising commonly to 40 feet, sometimes to upwards of 50 feet.

Monmouthshire shews a continuation of the old red sandstone. The great tunnel under the Severn is about seven miles south-west of Chepstow, and, if I remember right, there are at least two more considerable castles in this short ride; the Welsh must have been troublesome people in early times. We now entered the train for Bristol, which after a three miles trip under the bed of the Severn, landed us in the county of Gloucester and finally into Bristol, a city which not long ago used to boast of being the second port in England.

King Brennus, said to be the first king of the Britons, is reputed to be the founder of Caer-Odor, the "City of Odor,"

or perhaps the city of the chasms, now Bristol. To do justice to this ancient and still flourishing city and environments would require a separate paper, and here I can only say incidentally, there are some remains of an old castle and wall, a pretty little cathedral, the beautiful church called St. Mary's, Redcliffe,—Queen Elizabeth called it in her time as "one of the most famous, absolute, fairest, and goodliest parish churches within the realm of England." Equally famous is Clifton Bridge built over the Avon, binding together cliffs on each side of the river, 250 feet high, at a cost of £100,000. Hot wells are at the base of the cliffs. The short length of river, seven miles from Bristol to the Severn, is quite a show ground for the geologist. Even the ancients were struck with this, and accounted for the great gorge by one of their thrilling and veracious stories of giants. Old geologists attributed its formation to the "explosive force of vapours generated within the earth by subterraneous fires" (volcanoes); but the geologist of to-day believes that such ridges, as border or intersect the Avon basin, are the result of intense lateral pressure by which the strata were thrown into folds and afterwards by subærial denudation carved into their present forms. The rocks consist principally of fossiliferous limestone and have yielded multitudes of quartz crystals, known as Bristol diamonds.

I now conclude my paper by again reverting to the hope that this ground, in the no distant future, will be covered by our leading members, not only on the bicycle, but accompanied by one or more of our skilled photographers, who will find substantial fields of labour, and that labour one of delight and joy.

A FIELD MEETING

was held on Monday, 3rd August, 1896, at Bangor, conducted by Mr. R. W. B. Roberts, F.G.S.

The volcanic tuffs of Cambrian age were studied at the pleasure grounds on Bangor Hill, the Cambrian slates at

Penrhyn quarries and the carboniferous limestone at Menai Bridge.

A FIELD MEETING

was held on Saturday, 5th September, 1896, at Dawpool, conducted by Mr. J. H. Jones. The three-fold division of the glacial drift was noted. The great number of erratics were noticed in the upper clay, and fossil shells much broken, were collected from the middle sands and lower clay. On the return journey, attention was drawn to the junction of upper Bunter and lower Keuper rocks near West Kirby.

ORDINARY MEETING,

Held at the Free Library, Monday, 7th September, 1896, the President (Mr. T. R. Connell) in the Chair.

AUDITORS.—Messrs. J. M. Barber and J. W. Dunn were elected Auditors.

EXHIBITS.—Mr. J. H. Jones exhibited some echinoderms from the chalk beds of Hampshire.

The President exhibited a number of erratics and shells from the glacial deposits of Dawpool, and also gave a report of the Field Meeting held there on Saturday, 5th September.

Mr. R. W. B. Roberts, F.G.S., then exhibited and described a collection of

PRE-CAMBRIAN ROCKS FROM ANGLESEA

consisting of quartzite, serpentine, granite, gneiss, and schist.

This exhibition will be followed in a short time by a paper on the Geology of that Island.

Mr. D. Clague, F.G.S., next gave a brief description of a

"GEOLOGICAL RAMBLE IN THE NEIGHBOURHOOD OF SOUTH CROYDON."

A FIELD MEETING

was held at Doulton's Delph, St. Helens, on Saturday, 12th September, 1896, conducted by the Vice-President (Mr. D. Clague, F.G.S.)

On leaving the train at Thatto Heath, attention was drawn to the fault crossing the railway by which the coal measures are caused to rest against the pebble beds. A visit to Scholes Lane enabled the party to see it more clearly, and also to note its influence on the scenery of the district.

Doulton's Delph has been much altered since our last visit, portion of the quarry having been filled up and new excavations have been made; the coal seams are still visible, but in a relatively different position; fossils are abundant, especially Calamites, Lepidodendra, and Cordaites, several stools of which were observed in situ, but the most notable discovery was a recumbent tree stem, not less than twenty feet long; it was so far above reach that its size could not be accurately determined.

THE ANNUAL MEETING

was held at the Free Library, on Monday, 5th October, 1896, Mr. HAWORTH, Vice-President, in the Chair.

EXHIBITS.—Photographs of Manx rocks, taken during a recent visit, and splendid specimens of Lepidodendron from Wigan, were exhibited by Mr. Haworth.

The Annual Report of the Council and the Treasurer's Financial Statement were read and adopted.

The following Officers and Council were then elected to be the Executive for the year 1896-97:—

President: G. A. HAWORTH.

Vice-Presidents: T. R. CONNELL, C. F. WEBB, B.A., D.D.S.

Secretary: D. CLAGUE, F.G.S.

Assistant Secretary: MISS S. GLUCK.

Treasurer: J. HERBERT JONES.

Council: W. SCOTT WALKER, W. B. BARR, W. OWEN, F. J. LLOYD, MISS M. STEWART, L.L.A.

Annual Report,

SESSION 1895-96.

OCTOBER 5th, 1896.

THE year for which we were elected to office having reached its termination, it becomes now our duty to report to you the work of the year and our present position.

During the year, we have had an accession of three new members; none have resigned, but we regret that it has been necessary to remove 7 names from the list of members, under Rule III., for non-payment of subscriptions, leaving us 7 honorary, and 60 ordinary, being a loss of 4 members.

We have held nine Ordinary Meetings at which the following papers were read and discussed:—

"GLACIAL DEPOSITS NEAR WAVERTREE," by Wm. Owen.

"REPORT ON AN EXAMINATION OF AUSTRALIAN SHALE," by R. W. B. Roberts, F.G.S.

"BROKEN HILL AND BARRIER REEF MINERALS," by F. J. Spence, M.E.

"THE NITRIFICATION OF SOILS," by W. Scott Walker.

"OLD RED SANDSTONE OF PEMBROKESHIRE," by Wm. Owen.

"HOLIDAY STUDIES OF A GEOLOGIST," by D. Clague, F.G.S.

"FROM THE MERSEY TO THE SEVERN ON A BICYCLE," by W. B. Barr.

"THE STUDY OF THE PRE-CAMBRIAN ROCKS OF ANGLESEA," by R. W. B. Roberts.

"REPORT OF A GEOLOGICAL RAMBLE NEAR CROYDON," by D. Clague, F.G.S.

In addition to these papers, two evenings were principally devoted to a study of minerals. On the opening night of the session we had our own collection of Australian minerals spread out for inspection, on which occasion our President, in a very homely way, reviewed the work of the past and drew from them lessons to guide us in the future.

The second was on the occasion of Mr. Spence's paper on "The Broken Hill Minerals" being read, when several other collections of Australian minerals were exhibited.

On another of our Ordinary Meetings, instead of a paper, we had an interesting pictorial study of denudation, shewn by Mr. Conlan with his optical lantern, views of Alpine scenery illustrating glacial work, American views shewing river work, and British and other views, making clear the action of the sea.

In addition to these we have had five Field Meetings:—

On Easter Monday,—Rhydmwyn, conducted by Mr. F. J. Lloyd.
Whit Monday,—Ffrith, ,, Mr. J. H. Jones.
August Bank Holiday,—Bangor, conducted by Mr. R. W. B. Roberts.
Sept. 5th,—Dawpool, conducted by Mr. J. H. Jones.
,, 12th,—Doulton's Delph, ,, Mr. D. Clague.

The Library continues in good condition and has been enriched during the year by the addition of books, presented by friends or sister Societies. Members are making good use of it but not to the extent which is desirable.

The Committee appointed to aid members in their Petrological studies have done nothing beyond their own personal work, their services not having been requisitioned by any member. The Council feel, that if the Committee is appointed again, it should be with a view of suggesting some study, and they think that the time has come when good educational work may be accomplished by the appointment of Committees,

whose work shall not be so much to answer questions and solve difficulties when submitted to them, but to open out the way of study in some interesting and useful but neglected department.

The Committee appointed to examine and name the Australian minerals have practically concluded their work, the minerals properly named being now in the cupboard of the Association.

The Journal for session 1894-95 was completed early in the year, and after supplying our own members, copies were sent to all Societies with which we make exchanges. The Journal for the present year is in a fair way towards completion.

Your Council have pleasure in announcing that Dr. C. F. Webb has made an offer to devote a sum of money annually to be given in prizes for the best work done by members during the year. This offer your Council have accepted, and it will be one of the earliest works of the new Council to make such arrangements as will best carry out the wishes of the donor and the interests of our Association. Our thanks are due to Dr. Webb for this valuable and well considered offer.

We have to note that the British Association for the advancement of Science has just held its meetings in our city. Along with all other Science workers, we have been interested in those meetings and hope they will prove to have afforded a lasting stimulus to scientific work in Liverpool, and that the work of section C may not be the least important in its result.

The Treasurer's account appended shews a balance of cash in hand, but there are unpaid accounts which will leave us slightly in debt. This can easily be avoided by every member paying subscriptions promptly.

LIVERPOOL GEOLOGICAL ASSOCIATION, in Account with the Treasurer.

FOR THE YEAR ENDING 30TH SEPTEMBER, 1896.

Dr. DISBURSEMENTS.	£	s.	d.
To Printing and Stationery	10	19	6
,, Postages and Railway Charges	2	18	9½
,, Rent of Room	2	0	0
,, Gratuity to Attendant	0	10	0
	£16	8	3½
Balance in hand	5	2	2
	£21	10	5½

RECEIPTS.				Cr. £	s.	d.
By Balance from last year				*5	10	1½
,, Subscriptions, viz. :—						
3 for year	1892-93	£0	15	0		
3 ,,	1893-94	0	15	0		
12 ,,	1894-95	3	0	0		
36 ,,	1895-96	9	0	0		
4 ,,	1896-97	1	0	0		
58 at 5/-					14	10	0
,, Receipts for Extra Printing					0	15	0
,, Donation to Library Fund					0	2	6
,, ,, Binding Fund					0	2	10
,, ,, Towards Liquidating Debt					0	10	0
				£21	10	5½

20th October, 1896.—Audited and found correct,

(Signed) JAMES W. DUNN,
JOSEPH M. BARBER.

* £5 of the sum has been given for the benefit of the Library and has been paid over to Mr. T. R. Connell for the purpose of binding and buying new books, as arranged with the donors.

Exchanges and Donations to Library.

Copies of the *Journal* of the Association, Vol. XV., 1894-5, have been sent to the following institutions and societies, and exchanges received from those marked with a *.

GREAT BRITAIN AND IRELAND.

*Birmingham Natural History and Microscopical Society.
Bristol Naturalists' Society.
*Burnley Literary and Philosophical Society.
*Cardiff Naturalists' Society.
Chester Society of Natural Science and Literature.
*Cornwall Royal Polytechnic Society.
* ,, Royal Geological Society, Penzance.
* ,, Mining Association and Institute.
Cotteswold Naturalists' Field Club.
Cumberland and Westmoreland Association for the Advancement of Literature and Science.
*Isle of Man Natural History and Antiquarian Society.
Leeds Geological Association.
,, Philosophical and Literary Society.
Liverpool Astronomical Society.
,, Engineering Society.
* ,, Geological Society.
,, Literary and Philosophical Society.
,, Microscopical Society.
,, Naturalists' Field Club.
,, Polytechnic Society.
,, Science Students' Association.
,, University College.
*London British Museum, Natural History Department.
,, Geological Society.
* ,, Geologists' Association.

*Manchester Geological Society.
* ,, Microscopical Society.
Nottingham Naturalists' Society.
Northumberland Tyneside Geographical Society.
Norwich Geological Society.
*Rochdale Literary and Scientific Society.
*Sheffield Naturalists' Club.
*Yorkshire Geological and Polytechnic Society, Halifax.
* ,, Philosophical Society, York.
Edinburgh Geological Society.
Glasgow Geological Society.
Free Libraries—*Barrow-in-Furness, Birmingham, *Birkenhead, Bootle, Chester, *Liverpool, *Nottingham, Southport, St. Helens, Warrington.

AUSTRALIA.

*Australian Museum (Trustees of), Sydney, N.S.W.
Department of the Agent General, Sydney, N.S.W.
Geological Society of Australasia, Melbourne, Victoria.
Department of Mines, Melbourne, Victoria.
School of Mines, Stawell, Victoria.

NORTH AMERICA.

Geological and Natural History Survey of Canada, Ottawa.
*Nova Scotian Institute of Natural Science, Halifax, Nova Scotia.

UNITED STATES OF AMERICA.

*Geological Survey, Washington, D.C.
Smithsonian Institute, Washington, D.C.
*Elisha Mitchell Scientific Society, Chapel Hill, N. Carolina.
*Public Museum, Milwaukee, Wisconsin.
*Academy of Science, Arts and Letters, Madison, Wisconsin.
Wagner Free Academy of Science, Philadelphia.
Kansas Academy of Science, Topeka, Kansas.
Geological Survey, Des Moines, Iowa.
*Geological Survey, Jefferson City, Missouri.

California University, Berkeley, California.
State Mining Bureau, Sacramento, California.
*Scientific Association, Meriden, Connecticut.
*Society of Natural History, Boston, Massachusetts.
*Academy of Science, New York.

LIST OF DONATIONS.

T. Mellard Reade, C.E., F.G.S., F.R.I.B.A.:—

Paper, "The Moraine of Llym Cwm Llwch on the Beacons of Brecon."

Do. "Further Glacial Striæ at the Quarry, Little Crosby."

Do. "Pitted Pebbles in the Bunter."

Do. "Expansion theory of Mountain Evolution."

Do. "British Geology."

T. Mellard Reade, C.E., F.G.S., and T. W. Davies, Assoc. M.I.C.E.:—

Paper, "Description of the Strata exposed during the construction of the Seacombe branch of the Wirrall Railway."

T. MacKenny Hughes, M.A., F.G.S.:—

Paper, "Criticism of the Geological evidence for the recurrence of Ice Ages." 4 parts.

Do. "Some Chipped Flints from the Plateau Gravel of Salisbury and elsewhere."

Do. "The more important breeds of Cattle of the British Islands in successive periods."